# RECORDING MEDIUM HAVING DATA STRUCTURE FOR MANAGING REPRODUCTION OF MULTIPLE REPRODUCTION PATH VIDEO DATA RECORDED THEREON AND RECORDING AND REPRODUCING METHODS AND APPARATUSES

## FOREIGN PRIORITY

[0001]     The present invention claims priority under 35 U.S.C. 119 on Korean Application No. 10-2002-0072922 filed November 22, 2002; the contents of which are incorporated by reference in their entirety.

## BACKGROUND OF THE INVENTION

### Field of the Invention

[0002]     The present invention relates to a recording medium having a data structure for managing reproduction of at least multiple reproduction path video data recorded thereon as well as methods and apparatuses for reproduction and recording.

### Description of the Related Art

[0003]     The standardization of new high-density read only and rewritable optical disks capable of recording large amounts of high-quality video and audio data has been progressing rapidly and new optical disk related products are expected to be commercially available on the market in

the near future. The Blu-ray Disc Rewritable (BD-RE) is one example of these new optical disks.

[0004]     Fig. 1 illustrates the file structure of the BD-RE. The file structure or data structure provides for managing the reproduction of the video and audio data recorded on the BD-RE.  As shown, the data structure includes a root directory that contains at least one BDAV directory.  The BDAV directory includes files such as 'info.bdav', 'menu.tidx', and 'mark.tidx', a PLAYLIST subdirectory in which playlist files (*.rpls and *.vpls) are stored, a CLIPINF subdirectory in which clip information files (*.clpi) are stored, and a STREAM subdirectory in which MPEG2-formatted A/V stream clip files (*.m2ts) corresponding to the clip information files are stored.  In addition to illustrating the data structure of the optical disk, Fig. 1 represents the areas of the optical disk.  For example, the general information file info.bdav is stored in a general information area or areas on the optical disk.

[0005]     Because the BD-RE data structure and disk format as illustrated in Fig. 1 is well-known and readily available, only a brief overview of the file structure will be provided in this disclosure.

[0006]     As alluded to above, the STREAM directory includes MPEG2-formatted A/V stream files called clips or clip files. The STREAM directory may also include a special type of clip referred to as a bridge-clip A/V stream file. A bridge-clip is used for making seamless connection between two or more presentation intervals selected in the clips, and generally have a small data size compared to the clips. The A/V stream includes source packets of

video and audio data. For example, a source packet of video data includes a header and a transport packet. A source packet includes a source packet number, which is generally a sequentially assigned number that serves as an address for accessing the source packet. Transport packets include a packet identifier (PID). The PID identifies the sequence of transport packets to which a transport packet belongs. Each transport packet in the sequence will have the same PID.

[0007] The CLIPINF directory includes a clip information file associated with each A/V stream file. The clip information file indicates, among other things, the type of A/V stream associated therewith, sequence information, program information and timing information. The sequence information describes the arrival time basis (ATC) and system time basis (STC) sequences. For example, the sequence information indicates, among other things, the number of sequences, the beginning and ending time information for each sequence, the address of the first source packet in each sequence and the PID of the transport packets in each sequence. A sequence of source packets in which the contents of a program is constant is called a program sequence. The program information indicates, among other things, the number of program sequences, the starting address for each program sequence, and the PID(s) of transport packets in a program sequence.

[0008] The timing information is referred to as characteristic point information (CPI). One form of CPI is the entry point (EP) map. The EP map maps a presentation time stamp (e.g., on an arrival time basis (ATC)

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and/or a system time basis (STC)) to a source packet address (i.e., source packet number). The presentation time stamp (PTS) and the source packet number (SPN) are related to an entry point in the AV stream; namely, the PTS and its related SPN point to an entry point on the AV stream. The packet pointed to is often referred to as the entry point packet.

[0009] The PLAYLIST directory includes one or more playlist files. The concept of a playlist has been introduced to promote ease of editing/assembling clips for playback. A playlist file is a collection of playing intervals in the clips. Each playing interval is referred to as a playitem. The playlist file, among other things, identifies each playitem forming the playlist, and each playitem, among other things, is a pair of IN-point and OUT-point that point to positions on a time axis of the clip (e.g., presentation time stamps on an ATC or STC basis). Expressed another way, the playlist file identifies playitems, each playitem points to a clip or portion thereof and identifies the clip information file associated with the clip. The clip information file is used, among other things, to map the playitems to the clip of source packets.

[0010] A playlist directory may include real playlists (*.rpls) and virtual playlists (*.vpls). A real playlist can only use clips and not bridge-clips. Namely, the real playlist is considered as referring to parts of clips, and therefore, conceptually considered equivalent in disk space to the referred to parts of the clips. A virtual playlist can use both clips and bridge-clips, and therefore, the conceptual considerations of a real playlist do not exist with virtual playlists.

[0011]     The info.bdav file is a general information file that provides general information for managing the reproduction of the A/V stream recorded on the optical disk. More specifically, the info.bdav file includes, among other things, a table of playlists that identifies the file names of the playlist in the PLAYLIST directory of the same BDAV directory.

[0012]     The menu.tidx, menu.tdt1 and menu.tdt2 files store information related to menu thumbnails. The mark.tidx, mark.tdt1 and mark.tdt2 files store information that relates to mark thumbnails. Because these files are not particularly relevant to the present invention, they will not be discussed further.

[0013]     The standardization for high-density read-only optical disks such as the Blu-ray ROM (BD-ROM) is still under way. An effective data structure for managing reproduction of video and audio data recorded on the high-density read-only optical disk such as a BD-ROM is not yet available.

## SUMMARY OF THE INVENTION

[0014]     The recording medium according to the present invention includes a data structure for managing reproduction of at least multiple reproduction path video data (e.g., different camera angles of video data) recorded on the recording medium.

[0015]     In one exemplary embodiment, the recording medium includes a data area storing clip files of at least a video data stream. Each clip file is associated with one of a common reproduction path portion and a

particular reproduction path portion of the video data stream. In one exemplary embodiment, the clip files are interleaved. For example, the clip files associated with particular reproduction path portions are interleaved between the clip files associated with common reproduction path portions.

[0016] In another exemplary embodiment, the clip files have a size to prevent a reproducing apparatus buffer from under-flowing during reproduction of the clip files. In a further embodiment, the clip files have a size to prevent the reproducing apparatus buffer from over-flowing during reproduction of the clip files.

[0017] The present invention further provides apparatuses and methods for recording and reproducing the data structure according to the present invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The above features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0019] Fig. 1 illustrates the prior art file or data structure of a rewritable optical disk according to the Blu-ray Disc Rewritable (BD-RE) standard;

[0020] Figs. 2 illustrates an exemplary embodiment of a recording medium file or data structure according to the present invention;

[0021] Fig. 3 illustrates an example of a recording medium

having the data structure of Fig. 2 stored thereon;

[0022]     Figs. 4 - 5 illustrate embodiments of the data structure associated with reproduction path management for use in the data structure according to Fig. 2; and

[0023]     Fig. 6 illustrates a schematic diagram of an embodiment of an optical disk recording and reproduction apparatus of the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024]     In order that the invention may be fully understood, exemplary embodiments thereof will now be described with reference to the accompanying drawings.

[0025]     A high-density optical disk, for example, a Blu-Ray ROM (BD-ROM), BD-RE, etc. in accordance with the invention may have a file or data structure for managing reproduction of video and audio data as shown in Fig. 2. Many aspects of the data structure according to the present invention shown in Fig. 2 are similar to that of the BD-RE standard discussed with respect to Fig 1. As such these aspects will not be described in great detail.

[0026]     As shown in Fig. 2, the root directory contains at least one DVP directory.  The DVP directory includes a general information file info.dvp, menu files menu.tidx, menu.tdt1 among others, a PLAYLIST directory in which playlist files (e.g., real (*.rpls) and virtual (*.vpls)) are stored, a CLIPINF directory in which clip information files (*.clpi) are stored, and a

STREAM directory in which MPEG2-formatted A/V stream clip files (*.m2ts), corresponding to the clip information files, are stored.

[0027]    The STREAM directory includes MPEG2-formatted A/V stream files called clips or clip files. The A/V stream includes source packets of video and audio data. For example, a source packet of video data includes a header and a transport packet. A source packet includes a source packet number, which is generally a sequentially assigned number that serves as an address for accessing the source packet. Transport packets include a packet identifier (PID). The PID identifies the sequence of transport packets to which a transport packet belongs. Each transport packet in the sequence will have the same PID.

[0028]    The CLIPINF directory includes a clip information file associated with each A/V stream file. The clip information file indicates, among other things, the type of A/V stream associated therewith, sequence information, program information and timing information.  The sequence information describes the arrival time basis (ATC) and system time basis (STC) sequences.  For example, the sequence information indicates, among other things, the number of sequences, the beginning and ending time information for each sequence, the address of the first source packet in each sequence and the PID of the transport packets in each sequence. A sequence of source packets in which the contents of a program is constant is called a program sequence. The program information indicates, among other things, the number of program sequences, the starting address for each program

sequence, and the PID(s) of transport packets in a program sequence.

[0029]     The timing information is referred to as characteristic point information (CPI). One form of CPI is the entry point (EP) map. The EP map maps a presentation time stamp (e.g., on an arrival time basis (ATC) and/or a system time basis (STC)) to a source packet address (i.e., source packet number). The presentation time stamp (PTS) and the source packet number (SPN) are related to an entry point in the AV stream; namely, the PTS and its related SPN point to an entry point on the AV stream. The packet pointed to is often referred to as the entry point packet.

[0030]     The PLAYLIST directory includes one or more playlist files. The concept of a playlist has been introduced to promote ease of editing/assembling clips for playback. A playlist file is a collection of playing intervals in the clips. Each playing interval is referred to as a playitem. The playlist file, among other things, identifies each playitem forming the playlist, and each playitem, among other things, is a pair of IN-point and OUT-point that point to positions on a time axis of the clip (e.g., presentation time stamps on an ATC or STC basis). Expressed another way, the playlist file identifies playitems, each playitem points to a clip or portion thereof and identifies the clip information file associated with the clip. The clip information file is used, among other things, to map the playitems to the clip of source packets.

[0031]     A playlist directory may include real playlists (*.rpls) and virtual playlists (*.vpls). A real playlist can only use clips and not bridge-clips. Namely, the real playlist is considered as referring to parts of clips, and

therefore, conceptually considered equivalent in disk space to the referred to parts of the clips. A virtual playlist can use both clips and bridge-clips, and therefore, the conceptual considerations of a real playlist do not exist with virtual playlists.

[0032]    The info.dvp file is a general information file that provides general information for managing the reproduction of the A/V streams recorded on the optical disk. More specifically, the info.dvp file includes, among other things, a table of playlists that identifies the file names of the playlists in the PLAYLIST directory. The info.dvp file will be discussed in greater detail below with respect to the embodiments of the present invention.

[0033]    In addition to illustrating the data structure of the recording medium according to an embodiment of the present invention, Fig. 2 represents the areas of the recording medium.  For example, the general information file is recorded in one or more general information areas, the playlist directory is recorded in one or more playlist directory areas, each playlist in a playlist directory is recorded in one or more playlist areas of the recording medium, etc.  Fig. 3 illustrates an example of a recording medium having the data structure of Fig. 2 stored thereon. As shown, the recording medium includes a file system information area, a data base area and an A/V stream area. The data base area includes a general information file and playlist information area and a clip information area. The general information file and playlist information area have the general information file recorded in a general information file area thereof, and the PLAYLIST directory and

playlist files recorded in a playlist information area thereof. The clip information area has the CLIPINFO directory and associated clip information files recorded therein. The A/V stream area has the A/V streams for the various titles recorded therein.

[0034]     Video and audio data are typically organized as individual titles; for example, different movies represented by the video and audio data are organized as different titles.  Furthermore, a title may be organized into individual chapters in much the same way a book is often organized into chapters.

[0035]     Because of the large storage capacity of the newer, high-density recording media such as BD-ROM and BD-RE optical disks, different titles, various versions of a title or portions of a title may be recorded, and therefore, reproduced from the recording media.  For example, video data representing different camera angles may be recorded on the recording medium.  As another example, versions of a title or portions thereof associated with different languages may be recorded on the recording medium.  As a still further example, a director's version and a theatrical version of a title may be recorded on the recording medium.  Or, an adult version, young adult version and young child version (i.e., different parental control versions) of a title or portions of a title may be recorded on the recording medium.  Each version, camera angle, etc. represents a different reproduction path, and the video data in these instances is referred to as multiple reproduction path video data. It will be appreciated that the above examples of multiple reproduction path

video data are not limiting, and the present invention is applicable to any type or combination of types of multiple reproduction path video data. As will be described in detail below with respect to embodiments of the present invention, the data structures according to the present invention include path management information, navigation information, and/or are structured for managing reproduction of multiple reproduction path video data recorded on the recording medium.

[0036]     A first embodiment of the reproduction path management data structure for use in the data structure according to Fig. 2 will now be described with respect to Fig. 4.

[0037]     An original data stream includes portions of video data common to all reproduction paths and portions of video data specific to particular reproduction paths. According to an embodiment of the present invention, the respective portions are stored as clip files on the recording medium. More specifically, the clip files may be stored interleaved on the recording medium. Fig. 4 illustrates an example of the above-described embodiment of the present invention.

[0038]     As shown, an original data stream to be recorded on the recording medium (e.g., a BD-ROM) has an order of a common path data portion, a first reproduction path data portion, another common path data portion, and a second reproduction path data portion. The first common path data portion is managed as a first clip file Clip File #1, the first reproduction path data portion is managed as a second clip file Clip File #2, the second

common path data portion is managed as a third clip file Clip File #3, and the second reproduction path data portion is managed as a fourth clip file Clip File #4.

[0039]    The first through fourth clip files Clip File #1, Clip File #2, Clip File #3, and Clip File #4 are recorded in a physically interleaved fashion on the recording medium. As shown, the physical recording is successively carried out in the order of the first common path data portion of the first clip file, the first reproduction path data stream of the second clip file, the second reproduction path data portion of the fourth clip file, and the second common path data portion of the third clip file.

[0040]    Accordingly, the first reproduction path data portion of the second clip file and the second reproduction path data portion of the fourth clip file are recorded in an interleaved state between the first common path data portion of the first clip file and the second common path data portion of the third clip file.

[0041]    When a reproduction operation for the data of the second reproduction path is designated at the request of the user using an optical disc reproducing apparatus, the optical disc apparatus reads out and reproduces the first common path data portion of the first clip file, and then carries out a jumping operation to the second reproduction path data portion of the fourth clip file, as shown in Fig. 4. Thereafter, the optical disc apparatus carries out a reproduction operation for the second reproduction path by reading out and reproducing the second common path data portion of the

third clip file. Accordingly, the user can selectively play a data stream of a desired reproduction path.

[0042]     The length of each clip file should be appropriately set so as to prevent any buffer underflow from occurring during a jumping operation from one clip file to another clip file while preventing the buffer size from becoming excessively large. For example, in the case of an excessively short clip file length, a buffer underflow of the reproducing apparatus may occur during a big jump operation. Furthermore, there is a drawback in that it is necessary to manage a relatively large number of clip files.

[0043]     On the other hand, in the case of an long clip file length, the need for a buffer having a size adapted to temporarily store a read data stream may significantly increase the cost of the reproducing apparatus. For this reason, the length of each clip file is set, taking into consideration buffer underflow, buffer size, and efficiencies of recording and managing the clip file.

[0044]     Another embodiment of the present invention takes these factors into account by limiting the size of a clip file to a maximum file size Clip File_Max Size. As a consequence, one or more data portions of the original data stream may be stored as more than one clip file.

[0045]     Fig. 5 illustrates an example of this embodiment. As shown, an original data stream to be recorded on the recording medium (e.g., a BD-ROM) has an order of a common path data portion, a first reproduction path data portion, another common path data portion, and a second reproduction path data portion. The first common path data portion is

managed as a first clip file Clip File #1. The first reproduction path data portion, however, includes data exceeding the maximum file size Clip File_Max Size. Consequently, the first reproduction path data portion is broken into more than one clip file, each clip file including data less than the maximum file size Clip File_Max Size. In the example of Fig. 5, the first data portion is managed as second and third clip files Clip File #2 and Clip File #3. The second common path data portion is managed as a fourth clip file Clip File #4, and the second reproduction path data portion is managed as a fifth clip file Clip File #5.

[0046]     The first through fifth clip files Clip File #1, Clip File #2, Clip File #3, Clip File #4, and Clip File #5 are recorded in a physically interleaved fashion on the recording medium.   As shown, the physical recording is successively carried out in the order of the first common path data portion of the first clip file, the first reproduction path data stream of the second clip file, the second reproduction path data portion of the fifth clip file, the first reproduction path data portion of the third clip file, and the second common path data portion of the fourth clip file.

[0047]     Accordingly, the first reproduction path data portion of the second and third clip files and the second reproduction path data portion of the fifth clip file are recorded in an interleaved state between the first common path data portion of the first clip file and the second common path data portion of the fourth clip file.

[0048]     When a reproduction operation for the data of the second

reproduction path is designated at the request of the user using an optical disc reproducing apparatus, the optical disc apparatus reads out and reproduces the first common path data portion of the first clip file, and then carries out a jumping operation to the second reproduction path data portion of the fifth clip file, as shown in Fig. 5. Thereafter, the optical disc apparatus carries out a reproduction operation for the second reproduction path by reading out and reproducing the second common path data portion of the fourth clip file. Accordingly, the user can selectively play a data stream of a desired reproduction path.

[0049]      Fig. 6 illustrates a schematic diagram of an embodiment of an optical disk recording and reproducing apparatus according to the present invention. As shown, an AV encoder 9 receives and encodes audio and video data. The AV encoder 9 outputs the encoded audio and video data along with coding information and stream attribute information. A multiplexer 8 multiplexes the encoded audio and video data based on the coding information and stream attribute information to create, for example, an MPEG-2 transport stream. A source packetizer 7 packetizes the transport packets from the multiplexer 8 into source packets in accordance with the audio/video format of the optical disk. As shown in Fig. 6, the operations of the AV encoder 9, the multiplexer 8 and the source packetizer 7 are controlled by a controller 10. The controller 10 receives user input on the recording operation, and provides control information to AV encoder 9, multiplexer 8 and the source packetizer 7. For example, the controller 10 instructs the AV

encoder 9 on the type of encoding to perform, instructs the multiplexer 8 on the transport stream to create, and instructs the source packetizer 7 on the source packet format. The controller 10 further controls a drive 3 to record the output from the source packetizer 7 on the optical disk.

[0050] The controller 10 also creates the navigation, management, etc. information for managing reproduction of the audio/video data being recorded on the optical disk. For example, based on information received via the user interface (e.g., instruction set saved on disk, provided over an intranet or internet by a computer system, etc.) the controller 10 controls the drive 3 to record the data structure of Figs. 2, 4 and 5 on the optical disk.

[0051] During reproduction, the controller 10 controls the drive 3 to reproduce this data structure. Based on the information contained therein, as well as user input received over the user interface (e.g., control buttons on the recording and reproducing apparatus or a remote associated with the apparatus), the controller 10 controls the drive 3 to reproduce the audio/video source packets from the optical disk. For example, the user input may specify a path to reproduce. This user input may be specified, for example, via a menu based graphical user interface preprogrammed into the controller 10. Using the user input and the path management or change information reproduced from the optical disk, the controller 10 controls the reproduction of the specified path or changing the reproduction of the specified path as described above with respect to the embodiments of the

present invention.

[0052] The reproduced source packets are received by a source depacketizer 4 and converted into a data stream (e.g., an MPEG-2 transport packet stream). A demultiplexer 5 demultiplexes the data stream into encoded video and audio data. An AV decoder 6 decodes the encoded video and audio data to produce the original audio and video data that was feed to the AV encoder 9. During reproduction, the controller 10 controls the operation of the source depacketizer 4, demultiplexer 5 and AV decoder 6. The controller 10 receives user input on the reproducing operation, and provides control information to AV decoder 6, demultiplexer 5 and the source packetizer 4. For example, the controller 10 instructs the AV decoder 9 on the type of decoding to perform, instructs the demultiplexer 5 on the transport stream to demultiplex, and instructs the source depacketizer 4 on the source packet format.

[0053] While Fig. 6 has been described as a recording and reproducing apparatus, it will be understood that only a recording or only a reproducing apparatus may be provided using those portions of Fig. 6 providing the recording or reproducing function.

[0054] As apparent from the above description, the present invention provides a multiple reproduction path data stream managing method for high-density optical discs which can rapidly and accurately access the data streams of the path designated by the user in a jumped fashion in order to reproduce the data streams, while being capable of minimizing a

reduction in the recording efficiency of multi-path data streams.

[0055]     As will be appreciated from the forgoing disclosure, the present invention provides a recording medium having a file or data structure that permits managing and/or controlling navigation of the reproduction of video data on a multiple reproduction path basis. Accordingly, the present invention provides a greater level of flexibility in the reproduction of video data than previously available.

[0056]     While the invention has been disclosed with respect to a limited number of embodiments, those skilled in the art, having the benefit of this disclosure, will appreciate numerous modifications and variations there from. For example, while described with respect to a Blu-ray ROM optical disk in several instances, the present invention is not limited to this standard of optical disk or to optical disks. It is intended that all such modifications and variations fall within the spirit and scope of the invention.